EXHIBIT E

Filed on behalf of: Senior Party **WESTON** Paper No. _____

Filed by: Eleanor M. Musick – Lead Counsel
Scott H. Davison – Backup Counsel
Musick Davison LLP
12636 High Bluff Drive, Suite 400
San Diego, CA 92130
Phone: 858-724-2450
Facsimile: 858-430-2427
E-mail: eleanor@mdiplaw.net
scott@mdiplaw.net

Date filed: March 24, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ERIC Q. LI
and
QUIAN DIAO
Junior Party
(Patent 7,685,077 C1)

v.

JASON **WESTON**
and
ISABELLE GUYON
Senior Party
(Application 12/944,197)

Patent Interference No. 106,066 (JTM)
(Technology Center 2100)

DECLARATION OF HONG ZHANG, Ph.D.

The undersigned, HONG ZHANG, does hereby declare and state that:

1. I make the following declaration based on my own personal knowledge and belief, and if called to testify as a witness, I would and could testify competently thereto.

2. I have reviewed the Declaration of Jan P. Allebach, PhD (Exh. 2003 [Paper 0027]) submitted by Intel Corporation, as well as the exhibits referred to therein, and have been asked to provide rebuttal testimony to Dr. Allebach's opinion with regard to support vector machines (SVMs), support vector machine – recursive feature elimination (SVM-RFE), in particular, with regard to the level of ordinary skill in the art in or around March 2000, and factors relating to whether or not SVM-RFE would have been obvious to a person of ordinary skill in the art as of March 2000.

Professional and Educational Experience

3. I am a professor and department head in the department of Computer Science & Information Technology at Armstrong Atlantic State University in Savannah, Georgia, where I teach courses at all levels in mathematics and computer science.

4. I received a Bachelor of Science degree in Computer Science from Fudan University in 1982. Fudan University, located in Shanghai, China, is one of the most prestigious and selective universities in China. It is consistently ranked in the world's top 100 most academic universities. I won the Fudan University Mathematics Competition in 1979. In 1983, I was awarded a scholarship by the Chinese government to study in the United States. Once in the U.S., I studied Electrical Engineering at the University of Pittsburgh, where I received a Master of Science degree in 1984. Continuing my studies at the University of Pittsburgh, I received a Master of Arts and a PhD in Mathematics in 1986 and 1989, respectively. During my time at the University of Pittsburgh, I was twice

awarded the Andrew Mellon Fellowship.

5. I served as an instructor in the Department of Mathematical Sciences at Purdue University (Indiana) from 1989 to 1996. In 1995, I was a visiting Associate Professor in the Department of Biometry at the Medical University of South Carolina. As visiting faculty at Johns Hopkins University Medical Center (Maryland), I worked at the Center for Biomarker Discovery on Bioinformatics on peak detection methods for mass spectral data. At Mercer University in Macon, Georgia, I worked at the Institute for the Advancement of Computer Assisted Medicine.

6. I have served as a consultant on many software and analytical development projects for Union Switch and Signal, Inc., General Electric Company, the Department of Pharmacology at the University of Pittsburgh, and NeoGenomics Laboratories.

7. From 1996 to 2000, while serving as the vice-president and CIO of Horus Therapeutics, Inc. (later acquired by Johnson & Johnson), I helped develop computer-assisted methods for diagnosing diseases using neural networks, an earlier-generation machine-learning analytical technology.

8. From 2000 to 2002, I worked as a research scientist with BIOwulf Technologies (Savannah, GA). BIOwulf's patent portfolio was acquired by Health Discovery Corporation (HDC, Atlanta, GA) in 2004. Since 2004, I have been employed on a part time basis by HDC, doing work in the field of machine learning analytical methods, including support vector machines (SVMs). I currently hold the title of Senior Vice President for Computational Medicine at Health Discovery Corporation.

9. Since 2015, I have served as managing director and research scientist for Manifold Partners, LLC (San Francisco, CA), which provides quantitative investment strategies using advanced computational analysis methods, including support vector machine (SVM) technology.

10. I am a named inventor or co-inventor on seven issued U.S. patents, all relating to applications of learning machines for analysis of biomedical data and/or images. Of these seven patents, four are assigned to HDC, one is assigned to Horus Therapeutics, Inc., and one is assigned to NeoGenomics Laboratories, Inc. I have an additional pending patent application, also directed to applications of learning machines to flow cytometry data, which is assigned to NeoGenomics Laboratories.

11. I have authored books and academic journal publications covering developments in computer science and bioinformatics. A list of my publications is included in my curriculum vitae, which is provided as Exh. 1029.

12. I have been working continuously within the field of computer science, with particular focus on bringing machine learning and other advanced IT technologies to practical applications, since 1986.

SVM and SVM-RFE: Summary and Critique of Li's Expert's Conclusions

13. The description of SVM provided in Dr. Allebach's declaration at paragraphs 32 through 36 is consistent with commonly available tutorials on SVM technology. (Exh. 2003 [Paper 0027], 8:23 to 10:12). The ability to excerpt material from one of these tutorials does not confer on one the status of "expert" in SVM technology. Furthermore, his comment in paragraph 37 that an SVM could theoretically be performed manually is unrealistic and oblivious to the realities of the actual technology. (Exh. 2003 [Paper 0027], 10:13-11:3)

14. SVM, in its original form, is a classifier. It can be modified to perform regression. On the other hand, SVM-RFE is a tool for feature selection. In other words, SVM-RFE is designed for a completely different purpose. Contrary to Dr. Allebach's suggestions, it is not merely a variation of SVM. Due to the tremendous success of SVM, there have been many SVM lookalikes with rather trivial variations (including those described in Dr.

Allebach's publications). SVM-RFE is certainly not one of them. SVM-RFE contains SVM as one of its important component, but it is a different technology for a different purpose. Unlike the trivial SVM variations, SVM-RFE has enjoyed its own great success in a wide range of areas, as evidenced by a large number of publications of SVM-RFE applications, including the publications by Intel.

15. In paragraph 38 of his declaration (Exh. 2003 [Paper 0027]; 11:4-14), Dr. Allebach states that "SVM continued to develop *rapidly*" from 1963 to 1992. Twenty-nine years in the field of modern computing is practically *glacial*. The 1963 paper by Vapnik and Lerner that he references, "Pattern Recognition Using Generalized Portraits," (Exh. 2035[Paper 0059]) describes general concepts connected to pattern recognition. It was not until eleven years later that Vapnik and Chervonenkis first developed the field of statistical learning theory ("Theory of pattern recognition: Statistical problems of learning," Moscow: Nauka, 1974) upon which SVMs are based. Then, another 18 years later, the pieces were finally put together by Boser, Guyon and Vapnik, who presented their paper on SVM at the 1992 5th Annual ACM Workshop on Computational Learning Theory ("COLT '92") (Exh. 2036 [Paper 0060]), thus launching the SVM revolution. This can hardly be considered "rapid development", and Dr. Allebach's simplistic suggestion that all learning machines are obvious variants on the same theme trivializes the time and effort that it took to turn the fundamentals of statistical learning theory into a practically-applicable computational tool that is SVM.

16. The early works of SVM and related technologies were developed by sophisticated researchers with advanced graduate degrees from prestigious universities in mathematics, computer science and engineering. It is no accident that an inventor of SVM-RFE is one of people who invented SVM. It is a shame for Dr. Allebach to diminish and trivialize the pioneering work that has, by his own admission, has benefitted his work. See, e.g.,

Nguyen, M.Q. and Allebach, J.A., "Feature ranking and selection used in a machine learning framework for predicting uniformity of printed pages", IS&T International Symposium on Electronic Imaging 2017, pp. 166-173. (Exh. 1030.)

17. It is true that SVM existed before SVM-RFE. Dr. Allebach tries to argue that the ideas of RFE (recursive feature elimination) existed before SVM-RFE and, therefore, SVM-RFE must be obvious. However, even if the idea of feature elimination had been used in some other context, he completely fails to show that the SVM-based RFE process, the key concept of the SVM-RFE, predated Weston's invention thereof. Besides, it is not uncommon to create new processes using known components. SVM was essentially a combination of the hyperplane classifier and the "kernel trick", two well-known concepts that existed long before the SVM invention. Yet it took nearly 30 years from the first publication of these concepts before SVM was introduced by Boser, Guyon and Vapnik in 1992.

18. Computational complexity is a critical factor in modern algorithm development. In spite of the rapid technological development of computer hardware, problems with complexity beyond polynomial time are practically not solvable by any computers. Even the NP-complete (nondeterministic polynomial time-complete) problems are generally considered intractable. The feature selection problem, in its general form, is clearly intractable because an exhaustive examination of all 2^n subsets of features would be of exponential complexity. Therefore, any feasible algorithms on general feature selection will necessarily be approximate solutions with carefully constructed procedures to achieve near-optimal answers within reasonable time complexity. The statement by Dr. Allebach that "RFE can be theoretically performed by an individual with a pencil and paper" (Exh. 2003 [Paper 0027], 12:21) only serves to demonstrate his lack of basic understanding of the fundamental questions to which SVM-RFE are directed.

19. Because of the nature of the feature selection problem, it is extremely naïve to think of SVM and RFE as some sort of pluggable components that you could just randomly put together to create a new algorithm. This may be the common practice of so-called researchers to manufacture some publications, however, SVM-RFE certainly would not have been created by some mediocre machine learning practitioners using some mediocre tactics. SVM-RFE is an efficient algorithm with the time complexity bounded by $O(nd^2)$ where n is the sample size and d the dimension. The effectiveness of SVM-RFE has been demonstrated by numerous publications of successful applications in a wide range of areas.

20. The simplicity of SVM-RFE does not render its invention obvious or trivial. Many great ideas are simple. It is far too easy for us to say that light bulbs are simple. Theory of relativity is quite simple, using only basic college mathematics. I would argue that it was the simplicity of SVM-RFE and of SVM that enabled their widespread applications by ordinary engineers. As someone who has dedicated his nearly thirty-year career to the field of machine learning, I consider it irresponsible for Dr. Allebach to claim that anyone back in 2000 could or would have come up the same idea.

The Inventors: Educational Level, Sophistication, and Their Work

21. I have reviewed and am familiar with the subject matter of the Weston '197 application as well as the related Weston patents. I personally know and have worked with inventors Jason Weston and Isabelle Guyon.

22. Jason Weston earned a Ph.D. in machine learning at Royal Holloway, University of London and at AT&T Bell Labs in 2000, under the guidance of, among others, Vladimir Vapnik, the world-renowned expert in statistical learning theory and co-inventor of support vector machines. Dr. Weston is currently employed as a research scientist at Facebook AI Research ("FAIR"). (Exh. 1031)

23. Isabelle Guyon received her Ph.D. in electrical engineering in 1988, focusing on

artificial neural networks, from the Université Pierre et Marie Curie, Paris, France. From 1989 to 1994, Dr. Guyon worked as a researcher at AT&T Bell Labs, where, among other things, she co-invented support vector machines with her husband, Bernard Boser, and Vladimir Vapnik. (Exh. 1032; Exh. 2036 [Paper 0060]; U.S. Patent 5,649,068, Exh. 1033). Since 1996, Dr. Guyon has operated an independent consulting company, Clopinet (Berkeley, CA), which specializes in statistical data analysis, pattern recognition and machine learning techniques.

24. Dr. Weston and Dr. Guyon were considered among the world leaders in the field of machine learning in 2000, and continue to be recognized today as being among the most influential scholars in the field.

25. The first version of the manuscript of the paper that originally disclosed SVM-RFE, entitled "Gene Selection for Cancer Classification Using Support Vector Machines", which named Jason Weston and Isabelle Guyon as co-authors along with Stephen Barnhill and Vladimir Vapnik, was submitted for publication in the journal *Machine Learning* in 2000. This same manuscript was filed in the United States Patent and Trademark Office on March 22, 2000 as provisional application number 60/191,219, which application had the same title (Exh. 1010). For brevity, I will refer to this paper as "the Weston paper." The Weston paper was revised from its original version, with additional material that appeared in what was finally published in 2002 in *Machine Learning*, volume 46, pages 389-422. (Exh. 1034) The revised version of the Weston paper as published served as the primary disclosure for the applications that issued as the related Weston patents as well as for the Weston '197 application.

Educational Level and Sophistication of Active Workers in the Field

26. The table below summarizes the educational level and sophistication of active workers in the field as exemplified by the authors of the Mukherjee (Exh. 2017 [Paper

0041]), Bradley (Exh. 2018 [Paper 0042]) and Cortes (Exh. 2020 [Paper 0044]) references that are cited in Dr. Allebach's declaration. The first column identifies the "prior art" reference cited and discussed in Dr. Allebach's declaration (Exh. 2003 [Paper 0027]) with which each person is associated. This column also includes the exhibit number [in brackets] from which this person's biographical and professional information was obtained. The second column provides the person's degree, the year in which the degree was received, and the institution from which it was received. The third column lists each individual's position in 2000 at or around the time of Weston's invention of SVM-RFE, an indicator of his or her level of sophistication. The fourth column lists each person's current position (as available) from on-line resources such as LinkedIn® profiles, published professional biographies, or published CVs. This entry which indicates their ongoing commitment and exemplary achievement in the field.

Author Name (Reference)	**Degree**	**Position in 2000**	**Current Position**
Paul S. Bradley (Bradley, Exh. 2018 [Paper 0042]) [Exh. 1035]	PhD, Computer Science, 1998 University of Wisconsin-Madison	Researcher, Microsoft Research Data Management, Exploration and Mining Group	Chief Data Scientist, ZirMed, Chicago, IL
Corinna Cortes (Cortes, Exh. 2020 [Paper 0044]) [Exh. 1036]	PhD, Computer Science, 1993 University of Rochester, NY	Researcher, AT&T Bell Labs	Head, Google Research NY, Google, Inc.
Todd R. Golub (Mukherjee, Exh. 2017 [Paper 0041]) [Exh. 1037]	MD, University of Chicago	Faculty, Harvard Medical School/Broad Institute	Chief Scientific Officer, Broad Institute; Charles A. Dana Investigator in Human Cancer Genetics at the Dana-Farber Cancer Institute, professor of pediatrics at Harvard Medical School, Howard Hughes Medical Institute investigator

Jill P. Mesirov (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1038]	PhD, Mathematics, 1974 Brandeis University	Director, Computation Biology and Bioinformatics Program, Broad Institute of MIT and Harvard	Professor/Associate Vice Chancellor for Computational Health Sciences, Department of Medicine, University of California, San Diego
Sayan Mukherjee (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1039]	PhD, Computer Science, 2001 MIT	Graduate Student, Center for Biological & Computational (CBCL) Learning, MIT	Assistant Professor, Department of Statistical Science, Duke University
Tomaso Poggio (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1040]	PhD, Theoretical Physics, 1971 University of Genoa (IT)	Professor, Brain & Cognitive Sciences, MIT	Eugene McDermott Professor in the Department of Brain and Cognitive Sciences and at the Artificial Intelligence Laboratory, MIT
Massimiliano Pontil (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1041]	PhD, Physics, 1999 University of Genova (IT)	Post-doctoral Fellow, Center for Biological & Computational Learning, MIT	Professor of Computational Statistics & Machine Learning, Department of Computer Science, Centre for Computational Statistics and Machine Learning, University College London
Ryan Rifkin (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1042]	PhD, Machine Learning, 2002 MIT	Graduate student, Center for Biological & Computational Learning, MIT	Google, Inc. Mountain View, CA
Donna K. Slonim (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1043]	PhD, Computer Science, 1996 MIT	Postdoctoral associate, Center for Biological & Computational Learning, MIT and Broad Institute	Professor of Computer Science, Tufts University
Pablo Tomayo (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1044]	PhD, Physics, 1990 Boston University	Sr. Computational Biologist, MIT/Broad Institute	Professor, Department of Medical Genetics/Co-director, Genomics and Computational Biology, University of California, San Diego
Vladimir Vapnik (Cortes, Exh. 2020 [Paper 0044]) [Exh. 1045]	PhD, Statistics 1964 Institute of Control Sciences (Moscow)	AT&T Bell Labs	Professor, Center for Computational Learning Systems, Columbia University; Consultant, Facebook AI Research

Allesandro Verri (Mukherjee, Exh. 2017 [Paper 0042]) [Exh. 1046]	PhD, Physics, 1988 University of Genova	Visiting Scientist/Professor, Center for Biological & Computational Learning, MIT	Professor of Computer Science, Università degli Studi di Genova

27. The early works of SVM and related technologies were developed by extremely creative people working in respected universities and research institutions with profound knowledge and skills in mathematics, computer science and engineering. The individuals listed in the table are typical of those who were working in the field in 2000 and who advanced the technology to the point at which SVM and SVM-RFE could actually be used in practical applications by the far less sophisticated hypothetical person of ordinary skill in the art that Dr. Allebach describes in his declaration.

28. In the late 1990's and early 2000's, the active workers in the field of SVMs were close knit and highly collaborative, making up a kind of elite club of experts. The researchers who were working in the field knew everyone else – the technology was new and exciting and full of possibilities. The collegiality among those individuals led to exchanges of information and co-authoring of conference papers and journal publications across institutional boundaries. In one example, in a presentation at the 2000 conference on Neural Information Processing Systems (NIPS), Weston, working for Barnhill BioInformatics (a predecessor in interest to many of the HDC patents), Mukherjee, Pontil and Poggio, working at CBCL-MIT, and Chapelle and Vapnik, working at AT&T Research Labs, reported development of a new feature selection method for SVMs. The feature selection method described in this paper is a wrapper method that is completely unrelated to SVM-RFE. The paper, does, nonetheless, reference an early version of the Weston paper as reference [7], but distinguishes that method from what is disclosed in the instant paper and does not explicitly refer to "SVM-RFE." (Exh. 1047.)

29. In the years following publication of the Weston paper, the CBCL-MIT research

group (Center for Biological and Computational Learning at MIT), a major hub of artificial intelligence research and innovation, published several papers on the subject of using support vector machines for cancer classification. In each paper, the CBCL-MIT group credits Weston and Guyon as the source of SVM-RFE. Ramaswamy, et al, in "Multiclass cancer diagnosis using tumor gene expression signatures", *Proceedings of the National Academy of Sciences*, 98(26):15149-15143 (2001) (Exh. 1048) describe the use SVM-RFE for feature selection, citing to the Weston paper. Rifkin, et al., "An Analytical Method for Multi-class Molecular Cancer Classification", *SIAM Review*, 45(4):706-723, published 5 years after the 1998 Mukherjee paper (Exh. 2017 [Paper 0042]), describes the use of SVM-RFE. (Exh. 1049). In the Rifkin paper, the CBCL-MIT research group recognizes and describes the distinctions between conventional linear SVM and SVM-RFE. Similar discussions and distinctions between conventional SVM and SVM-RFE are offered by Mukherjee in "Classifying Microarray Data Using Support Vector Machines", Chapter 9 of *Understanding and Using Microarray Analysis Techniques: A Practical Guide*, Springer-Verlag, Heidelberg, 2003, pp. 166-185. (Exh. 1050). The CBCL-MIT group included researchers who were luminaries in their field. If they had thought Weston's SVM-RFE was simply an insignificant variation of conventional SVM, they would not have consistently recognized Weston's contribution of the SVM-RFE method.

Further Recognition of Acceptance in the Field

30. Further evidence of the recognition and acceptance that SVM-RFE has achieved in the field is provided by the large number of academic publications that have cited the Weston paper. The Weston paper represented a significant portion of the invention disclosure for the related Weston patents. A search for the Weston paper using Google® Scholar, a web search engine that indexes the full text or metadata of scholarly literature, yields results indicating that from publication in 2002 to 2017, about 5,300 books, academic

journals, conference papers, theses, technical reports, patents, and other publications have cited the paper as an authority in the field of SVM and feature selection. (Exh. 1051.) Breaking this down into smaller time windows, from its publication in 2002 to 2005, the year that Li filed its international patent application claiming to have invented SVM-RFE, Google® Scholar indicates that the Weston paper had already been cited nearly 500 times. (Exh. 1052). Since 2013, around the same time that Dr. Allebach first began co-authoring papers that describe the use of SVM in various printing applications, the Weston paper has been cited about 1,900 times according to Google® Scholar. (Exh. 1053). In the past year alone, Google® Scholar indicates that the Weston paper has been cited about 440 times. (Exh. 1054).

31. Other resources provide similarly impressive support for the recognized contribution that the SVM-RFE method has made to the field. For example, Springer, a respected publisher of academic journals and books, ranks the Weston paper in the 99th percentile for citations, with 2,299 items citing the article. (Exh. 1055). Another example, ResearchGate, a social networking site for scientists and researchers, reports 3,881 citations to the Weston paper. (Exh. 1056). This widespread and ongoing recognition would hardly be expected if it actually were the simple, obvious method that Dr. Allebach suggests it is.

32. . Dr. Allebach and his co-author Minh Nguyen are included among those who have utilized SVM-RFE and cited the Weston paper as a reference. In their 2017 conference paper, the authors describe the use of different approaches for feature selection, including the filter approach, into which category linear-SVM feature selection falls. The paper points out the drawbacks of the linear-SVM method, namely that it ignores feature dependencies. The authors then explain that wrapper methods, including SVM-RFE, make up for this drawback by combining feature selection and pattern classification. Thus, contrary to the sweeping generalizations he makes in his declaration that SVM-RFE is

merely an obvious variant of SVM, Dr. Allebach (and/or his co-author Nguyen) acknowledges that important differences exist that significantly impact the ways that the two methods perform and the accuracy of the results the two methods achieve. (Exh. 1030). (It may be noted that some authors describe two categories of feature selection methods, in which case they classify SVM-RFE into the category of wrapper methods. Others define three categories, and include SVM-RFE in the third category of "embedded" feature selection methods. In either case, the method is more accurate because it takes into account correlation among features.)

33. Dr. Allebach is a relative newcomer to the field of SVM and related machine learning technologies. He states in his declaration that he relies on his "*own experience and expertise* in the relevant technologies and systems that were already in use prior to the earliest alleged priority date...March 2000" (Exh. 2003 [Paper 0027], 4:11-14), however he presents no evidence to show that he has either experience or expertise in SVM until more than a decade later. His knowledge comes from hindsight, and only from the limited perspective of one who has used a tool, not one who had contributed to development of that tool. His lack of expertise and simplistic approach trivialize the creativity and hard work that went into Weston's invention of the SVM-RFE method -- a method that has been widely recognized by the inventors' *actual peers* (as opposed to Dr. Allebach's hypothetical person of ordinary skill in the art) as an important advancement in the field.

Documents and Other Materials Relied Upon

34. The documents on which I rely for the opinions expressed in this declaration are the documents and materials identified in this declaration, including exhibits previously produced by Intel Corporation, the Real Party in Interest for the Li patent, and any other references specifically identified in this declaration in their entirety, even if only portions of these

documents are discussed herein. I have also relied on my own experience and expertise in the relevant technologies, which includes experience and expertise that I personally had at the time referred to in Dr. Allebach's declaration (Exh. 2003, 4:13-14) as the "earliest alleged priority date" of the '197 application -- March 2000.

Compensation

35. I am an employee of HDC. I have received no additional compensation for providing my declaration in this matter.

Availability for Cross-Examination

36. In signing this declaration, I recognize that the declaration may be later filed and relied upon as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in the case, and that cross-examination will take place in within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

37. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements are made with knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statement may jeopardize the validity of any patent issuing from U.S. Patent Application No. 12/944,197.

Dated: March 24, 2017

Hong Zhang, Ph.D.